# CEPHALOMETRIC NORMS USING MCNAMARA ANALYSIS IN TAMILNADU YOUNG ADULTS

**Dissertation Submitted to**

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**in Partial fulfillment for the degree of**

**MASTER OF DENTAL SURGERY**

**BRANCH - V**

**ORTHODONTICS AND DENTOFACIAL ORTHOPEDICS**

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# CERTIFICATE

This is to certify that the dissertation entitled "**Cephalometric Norms Using McNamara Analysis In Tamilnadu Young Adults"** done by **Dr. R. Selvarani,** post graduate student (M.D.S), Orthodontics (Branch V), Tamil Nadu Govt. Dental College and Hospital, Chennai, submitted to the Tamil Nadu Dr.M.G.R.Medical University in partial fulfilment for the M.D.S. degree examination (April 2011) is a bonafide research work carried out by her under my supervision and guidance.

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# DECLARATION

I, **Dr. R. Selvarani**, do hereby declare that the dissertation titled "Cephalometric Norms Using McNamara Analysis In Tamilnadu Young Adults" was done in the Department of Orthodontics, Tamil Nadu Government Dental College & Hospital, Chennai 600 003. I have utilized the facilities provided in the Government Dental College for the study in partial fulfilment of the requirements for the degree of Master of Dental Surgery in the specialty of Orthodontics and Dentofacial Orthopaedics (Branch V) during the course period 2008-2011 under the conceptualization and guidance of my dissertation guide, Professor **Dr.C.KARUNANITHI, MDS.**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work and I firmly affirm that the right to preserve or publish this work rests solely with the prior permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

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# INTRODUCTION

The study of beauty and harmony of facial profile has been central to the practice of orthodontics in earlier days. People in a society must already enjoy the basic necessities of life such as food and shelter before it can consider provisions for art, beauty and comfort. With increased communication and the desire for social acceptance, interest has increasingly become focused on the face and the jaws. The standards of beauty change over time and across culture. As a result, physical anthropology as a scientific discipline has emerged to study the human face form. In classical anthropometry, the use of cephalometric studies was introduced, simultaneously in the United States and Germany (1931) by **B. H. Broadbent and H.Hofrath**[31] respectively and is today being constantly used in the evaluation of craniofacial variations.It is an essential tool in orthodontics to assist research workers and orthodontic clinicians in diagnosis and treatment planning. Cephalometric radiographs are taken on a cephalometer, which dictates a standardized orientation of the head and a precisely defined relationship among x-ray source, subject

and film. The cephalometric radiograph itself is the product of a two- dimensional image of the skull, enabling the relationship between teeth, bone, soft tissue horizontally and vertically.

It is a known fact that normal occlusion didnot dictate ideal facial esthetics and so perception of beauty or idealism of facial esthetics differ among racial groups. In a multicultural society, racial and ethnic differences are assuming an increasing level of importance. It brings with it the need to recognize that single standard norms may not be appropriate when making diagnostic and treatment planning decisions for a patient from diverse racial and ethnic backgrounds.

Cephalometric standards were gradually established for different racial groups, and it was indeed found that there was no universal cephalometric standard; but that cephalometric norms differ for different ethnic groups. In this way, a workable clinical cephalometric analysis can be utilized to define a beautiful or normal face in a population. Results of the evaluation may depend on the racial group

being examined and on the researcher. Several investigations have been carried out for various racial sub-groups, and information concerning cephalometric findings in the Caucasian[30],Japanese[51], Chinese[42],African Americans and Nigerians[37], Saudi population[59] is available.

A comprehensive and accurate diagnostic assessment of any orthodontic patient involves the comparison of the patient's cephalometric findings with the norms of his or her ethnic groups. Treatment plans and clinical procedure should not be freely switched without consideration of the racial group involved and without thorough understanding of the differences between races and their ranges of normal.

Cephalometric analysis was first popularized in the form of the Downs analysis which was developed at the University of Illinois and was based on skeletal and facial proportions. The reference group consisted of 25 untreated adolescent whites, selected because of their ideal dental occlusion **(Downs, 1948)[19]** .After the introduction of the Downs analysis, several other cephalometric analyses have been developed such as; **Steiner's analysis (Steiner, 1953)[63],** Moorrees template (Moorrees & Lebret, 1962), Sassouni

**(Sassouni, 1969)[61],** Wits (Jacobson,1975), Ricketts (Ricketts, 1981) and **McNamara (McNamara, 1984)[46].** Each of these analyses proposed their own landmarks and measurements.

To solve the problem of establishing cephalometric norms (reference standards), comparisons were made only with patients having excellent occlusion and facial proportions, as in the 25 individuals chosen for the Downs analysis **(Downs,1948)[19]** Perhaps the extreme of selectivity in establishing a reference standard was exemplified by **Steiner (1953)[63]** Later many analyses proposed many landmarks and measurements. McNamara analysis originally published in 1983, combines the elements of previous approaches with original measurements to attempt a more precise definition of jaw and tooth positions. This analysis has two major strengths that it relates the jaws via nasion perpendicular in essence projecting the difference in anteroposterior position of the jaws to an approximation of the true vertical line and secondly the normative data are based on the well- defined Bolton sample which is also available in template form meaning that it is highly compatible with preliminary analysis.

In this study, the cephalometric norms for the subjects with good occlusion and pleasing profile is estimated using Mcnamara analysis.

# AIMS AND OBJECTIVES

**AIM:** The aim of the study is to establish the cephalometric norms using McNamara analysis in TamilNadu young adults.

**OBJECTIVES:** The objectives are

1. To establish the cephalometric norms in young adults of TamilNadu using McNamara analysis.
2. To emphasize the digitization in cephalometry as an important tool in diagnosis and treatment planning.
3. To compare the obtained cephalometric values of males and females.
4. To compare the cephalometric norms of males and females with that of the McNamara norms.

# REVIEW OF LITERATURE

Background of Cephalometrics**:**

**In 1931, B. Holly Broadbent and Hoffrath**[31] simultaneously introduced the cephalometric radiography which was a scientific breakthrough in the practice of orthodontics.

**In 1947, Arne Bjork**[10] found the relationship of craniofacial structures to the facial profile.He developed a extensive list of cephalometric values utilizing a sample of 322 twelve year old boys, 281 swedish army conscripts and a control group of 20 other boys. His study however did not relate cephalometric norms to treatment difficulty, esthetics or favorability of outcomes.

**In 1948, William Downs** [19] presented one of the first comprehensive methods of hard tissue cephalometric analysis which utilised a set of normative values. His sample included 20 untreated , Caucasian individuals equally divided as to sex, aged 12-17 with clinically excellent occlusions.

**In 1951, Vorhies and Adams**[35] developed a polygon that expressed a large group of cephalometric readings graphically. A polygon has a vertical center line, which represents the average norms of the various measurements. The measurements were on to the left and the right of the center line stating either below average or above average.

**Riedel in 1952**[55] introduced the angle ANB which is considered by many orthodontists to be an important aid for assessment of the skeletal base relationship. He used two base planes, the anterior cranial base plane (sella -nasion) and the Frankfort (porion-orbitale) plane. The origin of this study for assessing the relationship of the maxillary and mandibular structure to the cranium in the normal and malocclusion states was based on Downs analysis.

**In 1954, Haralabakis**[29] used Down's analysis on Greeks and concluded that greek dentofacial pattern as a group differed from those studied via the same analysis by other investigators.

**In 1955, Wendell Wylie,** did a study using 29 patients consecutively treated by Tweed. He compared the relationship to profile esthetics to maxillary and mandibular central incisor position. He concluded that there is no clear cut relationship between soft tissue profile changes and inclination of the incisors.

In **1960, Robert Murray Ricketts**[56] stated that cephalometric synthesis yields a rough estimate of conditions most likely to occur and found that it should be considered a guide or an aid in the selection of the most intelligent and practical course to take in treatment planning.

**In 196 3, Savage**[62] studied the dental patterns of Bantu children of Tanganyika and concluded that bimaxillary protrusion was a general feature in all individuals.

**In 1965, Miura**[51] et al studied 90 Japanese children of age 7-12 years using steiner's analysis.They established the norms stating that the typical Japanese face had protrusive upper and lower incisors and more retrusive mandible.

**In 1969, Ravindra Nanda**[54] evaluated and established the norms for North Indian populations where 50 individuals equally divided as to sex were taken lateral cephalograph. He concluded that there was protrusive skeleto dental pattern in females and the North Indian Hindus were very similar to the American Whites.

**In 1970, Mills**[50] introduced an analysis which embraces features of the Tweed,Margolis, Downs, North-western and Ballard analysis. Skeletal and dental structures were appraised by angular measurements. The skeletal pattern was assessed anteroposteriorly by the ANB difference, and vertically by the maxillo –mandibular planes angle and by the lower face height proportion. As with the Steiner analysis, variations in the cant and length of the SN plane could affect the ANB difference and lead to misinterpretations.

**In 1977, Thomas E. Christie** [64] established standards of idealism in facial patterns in adults and correlated the information with various facial types according to vertical descriptions of growth and ethnic background.

**In 1981, Bishara**[11] studied 20 males and 15 female Caucasians with no apparent facial harmony. He explored the possibility of developing a limited number of normative cephalometric standards for males and females between 5 years of age and adulthood.

**In 1984, John S. Casko**[39] et al evaluated range of variation in various dental skeletal parameters in patients with untreated ideal occlusion.The study included 79 caucasian adults with ideal occlusion and no history of previous orthodontic treatment.

**In 1984, McNamara**[46] evaluated the cephalometric norms which were the composite normative standards by combining comparable average values of the Burlington, Bolton and the Ann Arbor samples.

**In 1998, Wen-Jeng Huang**[68] established age and sex specific normative data for Caucasians and African Americans in Birmingham. 136 subjects in the age group of 6-18 years were included and determined that most of the measurements were found to decrease with age. He

concluded that cephalometric norms should be based on racial, sex and age differences.

**In 2000**, **Abraham K.K, Tandon S**[1] conducted a study in 40 South Kanara children with a mean age of 8-12 years and concluded that the children showed a tendency towards Class II skeletal relation. Females showed a protrusive maxillary and mandibular base. Length of the maxillary and mandibular bases were standardized for class I cases. They also introduced new parameters on molar appraisal.

**In 2001, Bhat , Sudha**[7] studied the cephalometric norms for the brahmins and Bunt children of Dakshina using Mcnamara analysis. They confirmed that the kanara children had advanced maxillary growth in Bunt boys and girls, longer lower anterior facial height in bunt boys than the Brahmin girls and proclination of upper incisors in bunt girls than Brahmin girls.

**In 2001, by Hamdan et al** [28] a study was conducted for Jordanian population which consisted of 65 subjects aged 14-17 years equally divided into males and females with

Arabic ethnic background. They concluded that no statistically significant differences in SNA,SNB,ANB whereas MMPA was lower in the Jordanian population.

**Hyder Abdullah Hashin in 2002**[33] studied 25 lateral cephalographs of Saudi female dental students with pleasing profile. He concluded that Saudi females demonstrated retrusive upper and lower lips, increased upper lip length and possessed straight profile.

**In 2002, Jon M.H Dibbets** [37] compared the linear cephalometric dimensions in Americans of European descent and Americans of African Descent.

**In 2005, Badreia Al –Jame**[5] established lateral cephalometric hard tissue norms for adolescent Kuwaitis and compared them with published norms. Digital lateral cephalographs of 162 were taken and measurements were calculated electronically using Dolphin version of software package. He concluded that Kuwaitis had steeper mandibular plane, more convex profile and more protrusive dentition.

A study was performed by **Birgit Thilander** in **2005** [9] to establish age and gender specific cephalometric normative data for Swedish population. The material comprised 469 lateral cephalograph from two groups of subjects of Swedish origin between 5-31 years of age.The longitudinal study concluded that craniofacial distances were constantly larger in males than in females.

**In 2005 Ali H Hassan** [2] have established specific cephalometric norms for children living in western region of Saudi Arabia and concluded that Saudi children tend to have a significantly shorter and lower face height, a larger angle of convexity, and more proclined and protruded incisors when compared with adult Saudis.

**In 2005 Nasser Al Jasser** [52] described the craniofacial pattern of Saudi ethnic groups and compared it with accepted standards for the Caucasian population according to Steiner analysis.

**In 2006,Nasser-al- Jasser** studied the lateral cephalometric radiographs of 60 selected Saudis (30 males

and 30 females) with esthetically pleasing and harmonious faces, Angle I molar relationship, with all permanent teeth present and no history of orthodontic treatment or facial trauma, age range between 20 and 30 years were analyzed using the Downs and Steiner analysis.He concluded that normal Saudis have a slightly protrusive maxillae, a tendency to Class II facial pattern, and a high mandibular plane angle. These results have clinical implications in the diagnosis and treatment of adult Saudis with dentofacial deformities.

**In 2006, Ali H Hassan** [3] did a study in Saudi adults living in Western region of Saudi Arabia. Seventy lateral cephalometric radiographs of Saudis consisting of 32 females and 38 males, aged 18–28 years with acceptable profiles and Class I dental relationships were traced and analyzed. He concluded that Saudis tend to have an increased ANB angle because of retrognathic mandibles and bimaxillary protrusion as compared with European-Americans. Males tend to have more prognathic mandibles than females as indicated by the statistically significant increase in facial angle and the anterior lower face height

was similar in males and females, males tend to have a steeper mandibular plane angle when related to the anterior cranial base than females.

**In 2006, Hamamci et al** [27] evaluated longitudinal craniofacial changes in 14 males and 14 females in Turkish subjects using Mcnamara analysis.They observed remarkable mandibular growth augmentation from 9 to 18 years in both sexes, and the effective mandibular length changes were nearly double the maxillary length changes. In both sexes, the mandibular plane angle decreased, while the lower anterior face height increased. Angles SNA and SNB increased remarkably, and angle ANB decreased.

**In 2007, Hideki koi**[30] determined the Japanese cephalometric norms in the anteroposterior and vertical dimension. He concluded that Japanese subjects had a significantly more retruded chin position, protruding mandibular incisors and protruded lip positions compared with the Caucasian norms.

**In 2007, John Wu, Urban Hagg, Bakr M Rabie** [42] established cephalometric norms of Mcnamara analysis in young Chinese and compared them to those of a matched young Caucasian sample. Two hundred male and 207 female 12-year-old southern Chinese schoolchildren were selected by a partially stratified random sampling method from 10 schools in Hong Kong and concluded that effective maxillary length was larger, maxillomandibular length was also longer in males than in females.

**In 2007, AlBarakati and Talic** [59] studied 65 lateral cephalometric radiographs according to McNamara's analysis. It was revealed that Saudis have a greater convex profile with reduced chin prominence, steeper mandibular plane angle, and more bimaxillary protrusion.

**In 2007, Mohammed –El –Hadidy et al** [47] evaluated the measurements of the nasal profile of Egyptian adult males and females.

**Mohammad Hossein Ahangar Atashi in 2008** [48] established soft tissue cephalometric standards in Iranian

adults based on NHP, which can be used in diagnosis of orthodontic and orthognathic patients. . A group of 46 individuals (24 males and 22 females) with normal occlusion and proportional facial profile were chosen from a large group of dental students. For the all of the chosen sample, lateral cephalograms were obtained with head oriented in natural position. On the basis of thetrue horizontal and true vertical lines, the standard values of 19 soft tissue measurements were determined using McNamara, Burstone and Viazis methods.

**In 2008, Ildiko Csiki1**[34] evaluate the skeletal status particular to Hungarian adolescents with malocclusion and to determine whether significant cephalometric differences exist between this measurements and accepted standards for Caucasian population.

In **2008, Fouad Ayoub**[22] evaluated the forensic norms of female and male Lebanese adults in which lateral cephalographs of 63 individuals were taken and concluded that male skeletal linear and angular measurements are

significantly larger in Lebanese adult males compared to Lebanese adult females.

In **2008, Anmol S.Kalhaa** [6] established the soft tissue cephalometric norms in South Indian ethnic population in which 60 lateral cephalographs were taken in natural head position and analysed with soft tissue cephalometric analysis. He concluded that South Indian subjects have more deep-set midfacial structures and more protrusive dentititon. Men showed longer faces and women have greater interlabial gap and maxillary incisor exposure.

**In 2009, Laila F. Baidas et al** [43] compared the hard tissue analysis obtained from Saudi adults with reference data of Japanese and African- American adults.He collected 62 lateral cephalographs , 31 males and 31 females of age group 22-24 years, and determined the differences of hard tissue between different ethnic groups.

**In 2009, Lara-Carrillo, E; Kubodera** [44] established cephalometric norms by age and gender of Harvold's

analysis for people living in the central region of Mexico and Compared them with other population.

**DIGITIZATION:**

**In 1960 Ricketts R.M.**[56] introduced his cephalometric analysis that has progressed through a series of modifications and been adapted to a computer-based diagnostic and treatment forecasting service.

**Welcker in 1966** used a semi-automatic scanning system based on digitizing equipment. Each lateral skull tracing was marked at 177 defined points.

**Dr. Krogman and Dr. Walker in 1963** worked upon the initial work done by the researchers in Newzealand and made many innovation in computer based diagnosis and treatment planning.

**In 1972, Robert M. Ricketts** [57] suggested the benefits of the computer-aided cephlometrics for the orthodontists and his patients. These included its use in diagnosis, treatment

planning, case presentation and public relation, the monitoring of the results and its applications in research.

**In 1976 Chebib**, **Cleall** and **Carpenter** [15] suggested an ″On-line computer system-cephalometric records analysis program″ which was developed with primary objective of immediate clinical analysis of cephalometric radiographs for diagnosis. This eliminated the digitization of the records on to punch cards, which is a time consuming process.

**In 1978**, **Farber** and **Burstone** [21] presented an integrated simulation system with the capabilities of planning orthodontic treatment by means of computerized interactive graphic system. The system has been developed to include the orthodontic clinician for making key decision and using the computer program to perform the routine task and calculations.

**In 1980, Sheldon Baumrind et al** [8] described the construction of a rudimentary machine –the readable data base for research and clinical purposes.

In **1980 J.A Salzmann** stated that c omputer technology employed at present in orthodontics is used mainly as an aid in determining the rate and direction of dentofacial growth on the basis of cephalometric analyses. The data thus obtained are correlated with treatment plans and the procedural method of treatment.

**In 1980, G. B. Scheideman** selected 56 adults Caucasians with class I skeletal , dental relationships and good vertical facial proportions . He analysed morphologically with a computerised craniofacial model.The data provided the relevant measurements that are useful in the diagnosis and treatment of adults with dentofacial deformities.

**Cohen in 1984** [14] investigated the reproducibility of the measurements between the Direct and indirect digitization of tracing and concluded that anatomical landmarks were identified more reliably when direct digitization was used. He suggested that direct observation is the method of choice.

**Hing in 1989** investigated the accuracy of a commercially available software program that included prediction tracings. Although the program overestimated anteroposterior changes and under-estimated vertical changes, the mean differences and standard deviations tended to be less than those associated with manually derived predictions.

**In 1990, Davis and Mackay** did a study that compares the cephalometric analysis using manual and interactive computer graphics methods. Results are statistically in favor of the interactive computerized system. It could be performed in 10% of the time of a normal manual registration.

**Chaconas**, **Engle** and **Gianelly in 1990** [12] introduced a non-radiographic diagnostic system called ***'Digigraph'*** which is a synthesis of video, computer and three-dimensional sonic digitizing that can generate and control powerful and compelling diagnostic information faster and in a more simpler way.

**Isaacson et al, 1991** showed that the digitization process removes human errors except for error of landmark identification. Again, this error can be overcome by use of double digitization and thus significantly increases the reliability and accuracy of cephalometric analyses.

**In 1998, W.Geelan A Wenzel** [23] evaluated and compared the reproducibility of cephalometric landmarks on conventional films and digital radiography on hard copy and monitor displayed versions. He concluded that there was no significant difference between film and hardcopy and monitor displayed images had a lower precision than film.

**In 2001**, **F.Gijbels** [24] compared the clinical efficacy of digital and conventional cephaometric imaging. He used conventional and photo stimulable phosphor cephalometric radiographs obtained from three human cadavers at nine different exposure settings and concluded that small variations in exposure settings didnot influence subjective diagnostic image quality of digital cephalometric radiographs.

**Ashish Dhopatkar, Suren Bhatia in 2002** suggested that there was a relationship between the degree of cranial base flexion and type of malocclusion where they selected 200 cephalometric radiographs with good occlusion and analysed the method of digitization.

**In 2006, Gregory Anderson et al** [26] did a study to develop a cephalometric determination of anteroposterior skeletal occlusion on the basis of a clinically rational ‘‘gold standard’’ and objectively determined cut points. Pretreatment cephalograms from 10- to 18-year-old Caucasian patients with a normal vertical face dimension were digitized. Facial profile line drawings were judged by orthodontist raters as Class I, II, or III. Subjects who met all inclusion criteria were divided intoClass I, Class II, and Class III on the basis of the matched skeletal (facial) and dental occlusion and comprised our gold standard for anteroposterior skeletal occlusions. Cephalometric variables included ANB angle, McNamara analysis, Harvold unit differential, anteroposterior dysplasia index (APDI), and Wits analysis. Half the sample was used to derive skeletal classification norms using receiver operator characteristic

(ROC) curves, and half the sample was used to test for diagnostic ability and to compare the diagnoses based on traditional cephalometric norms with the new norms.They concluded that ANB and McNamara analysis performed well with traditional and ROC-derived norms, whereas Wits, Harvold unit differential, and APDI showed fewer errors in diagnosis with ROC norms compared with traditional norms.

**In 2009, Erkan Celik** [20] evaluated the accuracy and reliability of angular and linear cephalometric measurements using a computerized method of direct digital radiographs. In this study 125 patients digital cephalographs were traced and hand tracing were also made.He concluded that computerized cephalometric measurements using direct digital imaging was inherently preferable for its user-friendly and time saving method.

**Thurzo A** in **2010** [66] compared the manual and digital cephalometric analysis and did a new procedure of analog cephalogram digitization. He concluded that software analysis can fully substitute the manual method . He

evaluated 40 repeated measurements using Dolphin Imaging version.

**In 2010, Cleomar Donizeth Rodrigues et al** [16] did a study to evaluate the indirect digitization method of cephalometric radiographs in comparison with the direct digital method. The sample comprised 10 lateral cephalographs acquired by orthopantograph as direct digitization. The indirect digitization was done by Sc Jet 4C scanner. Both the images were gauged in Radiocef studio software. They concluded that images from the scanner demonstrated small statistically significant alterations, without clinical significance.

# MATERIALS AND METHODS

The study was conducted on total of 100 standardized lateral cephalometric radiographs (50 males and 50 females). Sample radiographs of this study were selected from the archives of cephalometric radiographic files taken by undergraduate students for their course requirements in the department of orthodontics Tamilnadu government dental college and hospital Chennai. The age range of the radiographs was young adults within 19-26 years. Radiographs of subjects below the age of 19 years were excluded to rule out the growth factors.

**Selection criteria**:

All radiographs were selected on the basis of a well balanced, accepted facial profile with normal occlusion and within acceptable limits of dental and skeletal relations. They had a class I molar relation with full complement of permanent teeth excepting third molars in proper intercuspation and acceptable over jet and overbite. Very mild crowding or rotations are acceptable. Selected subjects

had undergone no previous history of orthodontic management.

The lateral cephalographs **fig (1)** selected for this study were taken in natural head position, kodax 70kvp, 30mA, for 1.8seconds from fixed distance of 60inches taken from the same cephalostat. Two points were marked on each radiograph along the plumb line at a distinct distance. These marks were used to adjust the magnification of the radiographs. All the radiographs are scanned **fig( 2)** with HP Scanjet G3110 and converted into a digital format. A Cephalometric analysis software **fig(3)** vistadent OC was used to analyze the radiographs. All radiographs were categorized in to males and females with respective identification numbers.

The major landmarks used for McNamara analysis are presented in **fig(4)** the angular and linear measurements used in McNamara analysis are given in table. 1

**Table 1.** Different angular and linear measurements of McNamara's analysis

| Measurement | Definition |
|---|---|
| Maxilla to cranial base | The linear distance between nasion perpendicular and point A. An anterior position of point A is a positive, and a posterior position is a negative value |
| Effective midfacial length | The length in mm from condylion to point A |
| Mandible to cranial base | The distance between pogonion and nasion perpendicular. An anterior position of pogonion is a positive value and posterior position is negative value |
| Effective mandibular length | The length in mm from condylion to gnathion |
| Max-mandibular difference | The midfacial length is subtracted the mandibular length |
| Lower anterior face height | The distance from ANS to menton |
| Mandibular plane angle to FHP | The angle between mandibular plane and Frankfort horizontal plane |

| | |
|---|---|
| Facial angle | The angle between the line PTM to gnathion and the basion-nasion plane |
| Upper incisor to point A | The distance between the facial surface of the upper incisor and the line passing through point A parallel to N-perpendicular |
| Lower incisor to A-Pog plane | The distance between the edge of the lower incisor and the point A to pogonion plane |

The major reference line used in this analysis are the Frankfort plane, S-N plane, N-Ba plane and N-Perpendicular plane which is a line dropped from N, perpendicular to Frankfort plane,angular and linear measurements of McNamara's analysis. The radiographs were digitized and landmarks were identified. The process of digitization, landmark identification and analysis was carried out by one investigator. The computer analysis software produced the measurements according to McNamara's analysis.

The measurements were recorded for each radiograph. Descriptive data, means and standard deviations were calculated for the tamilnadu young adults male and female sample. The means of the tamilnadu young adults male and female were compared and to the means of McNamara's norms.Ten cephalometric radiographs were randomly selected and digitized again after three weeks interval by the same investigator to determine the intra-examiner error.

***Fig 1 Cephalostat***

***Fig 2 HP Scanjet G3110***


***Fig 3 VISTADENT cephalometric analysis software***

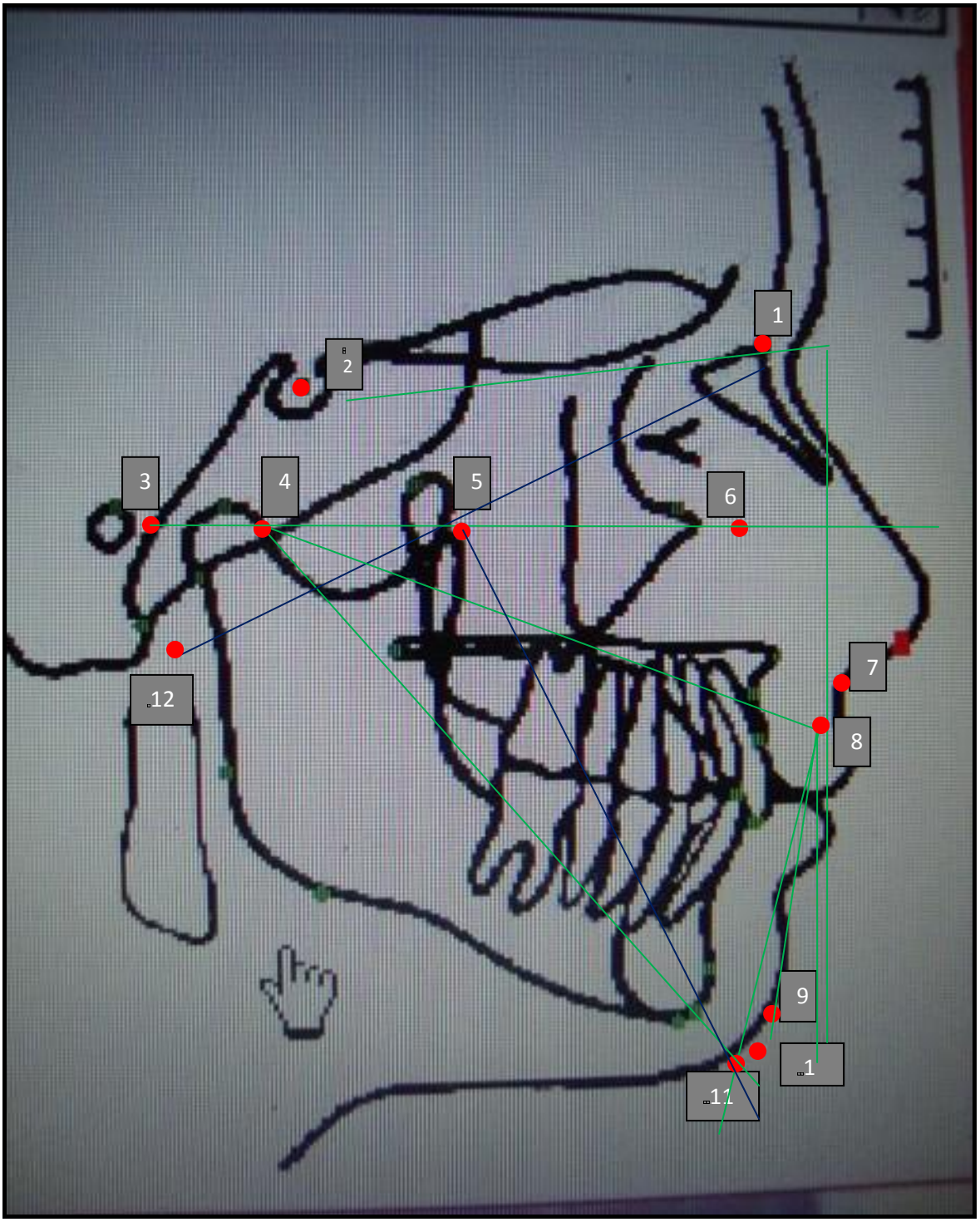



***Fig 4 Major landmarks and measurements***

The landmarks are,

1- Na –nasion

2- S – sella tursica

3- Po –porion

4- Co –condylion

5- Ptm –pterygo maxillary fissure

6- O –orbitale

7- ANS- anterior nasal spine

8- Pt A – point A

9- Pog –pogonion

10- Gn –gnathion

11- Me –menton

12- Ba – basion

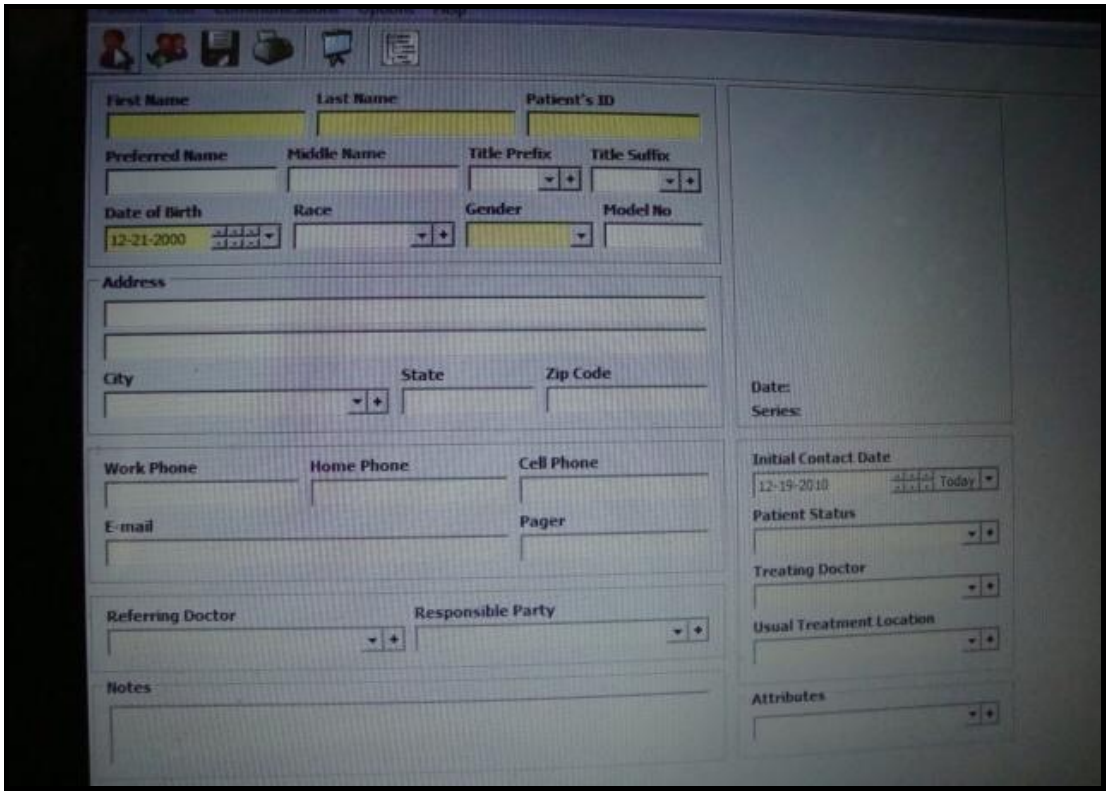



***Fig 5 Patient records***

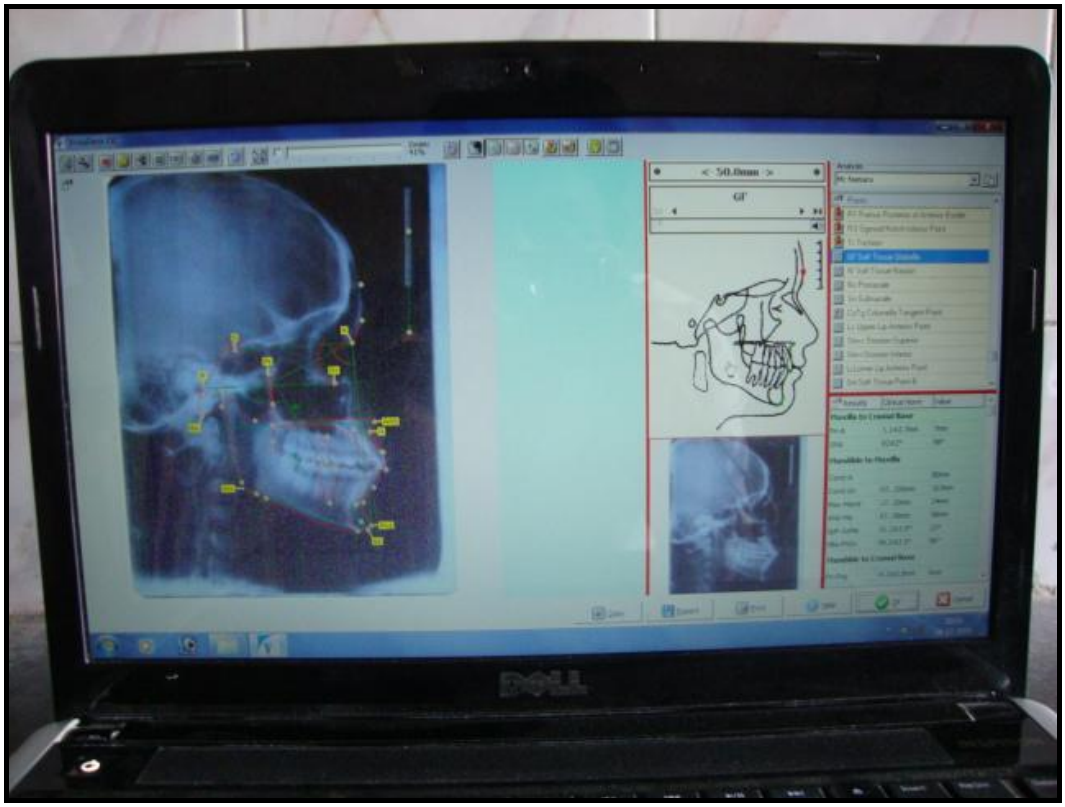


***Fig 6 Digitization process***

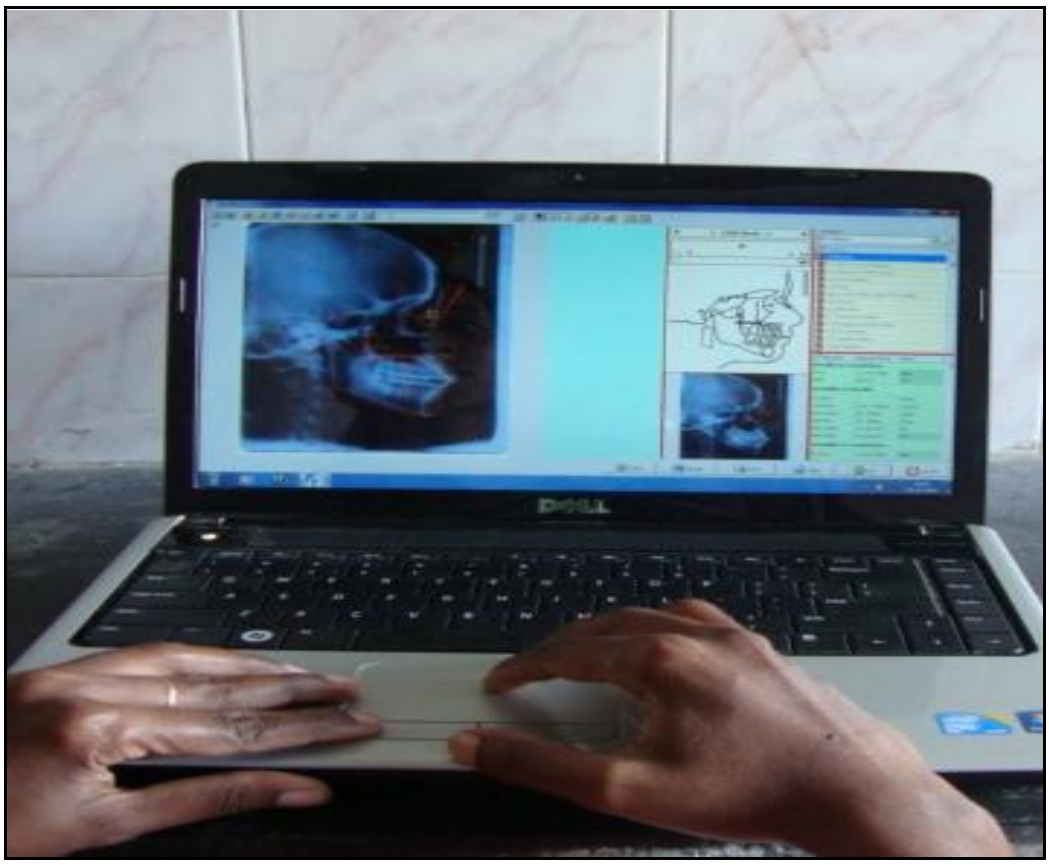


***Fig 7 Digitization with McNamara analysis***

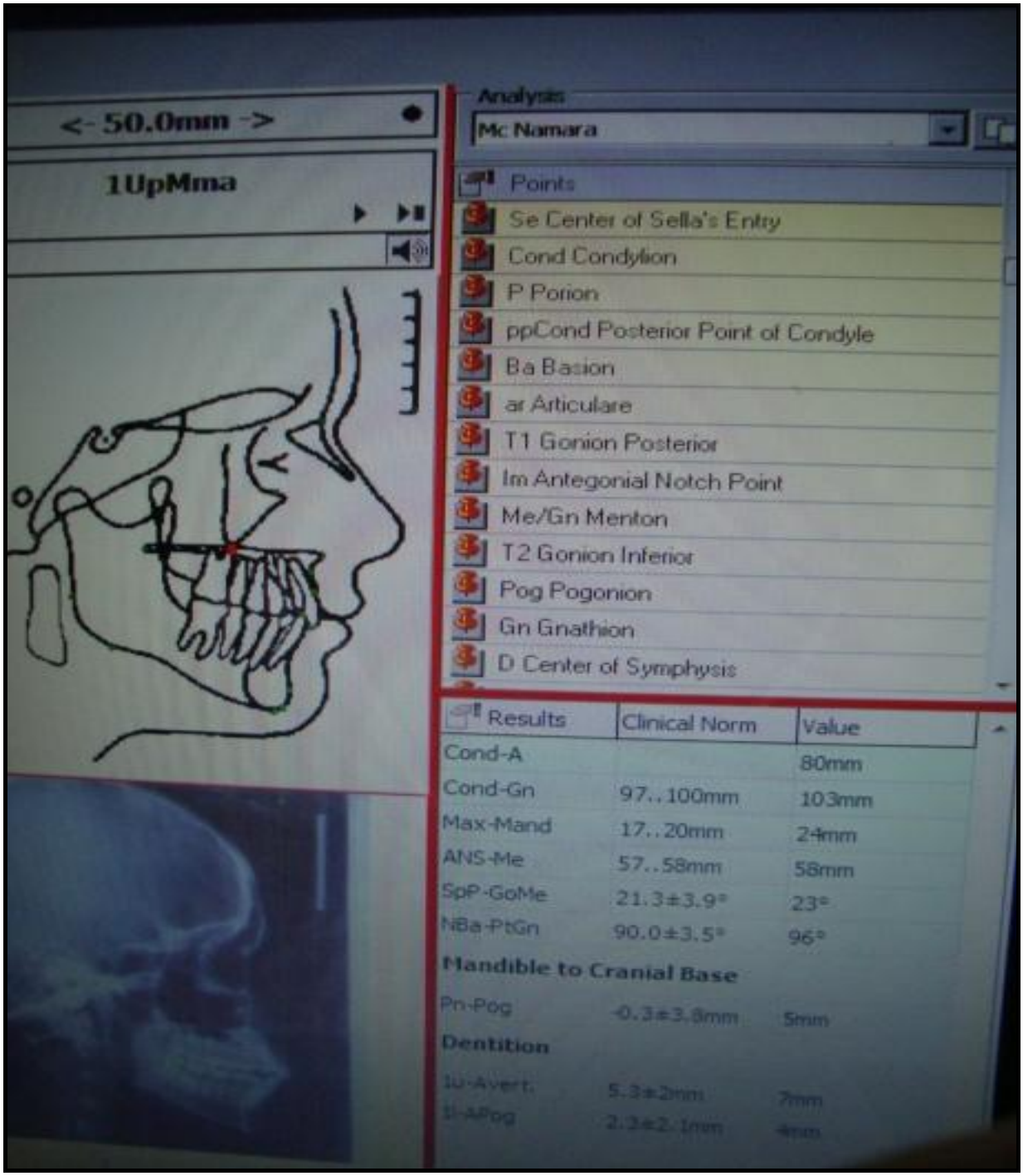



***Fig 8 Clinical norms and the values***

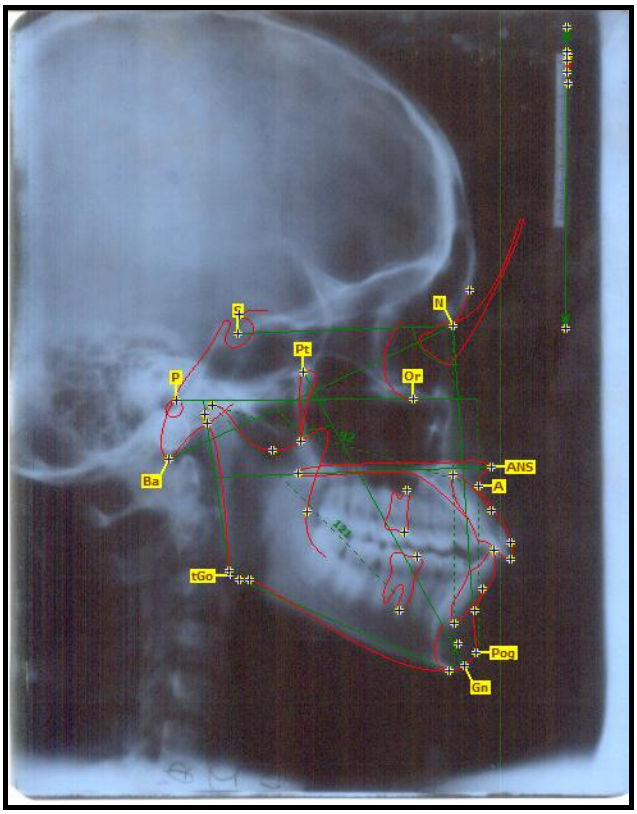



***Fig 9 Original image and tracing***

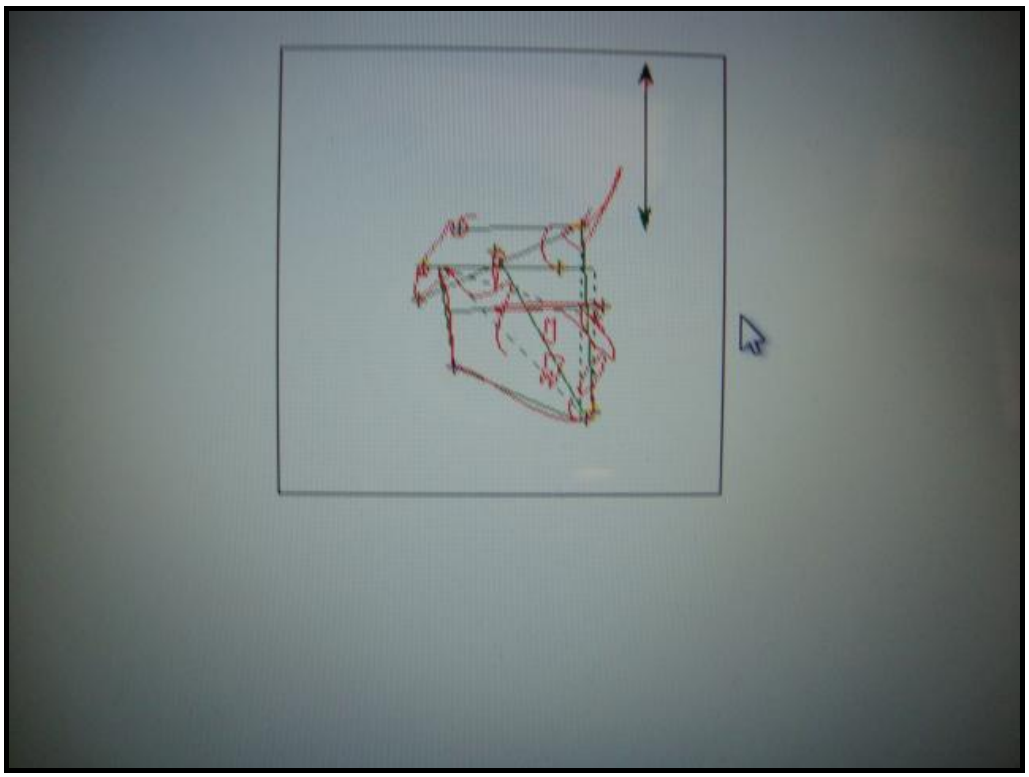


***Fig 10 Tracing***

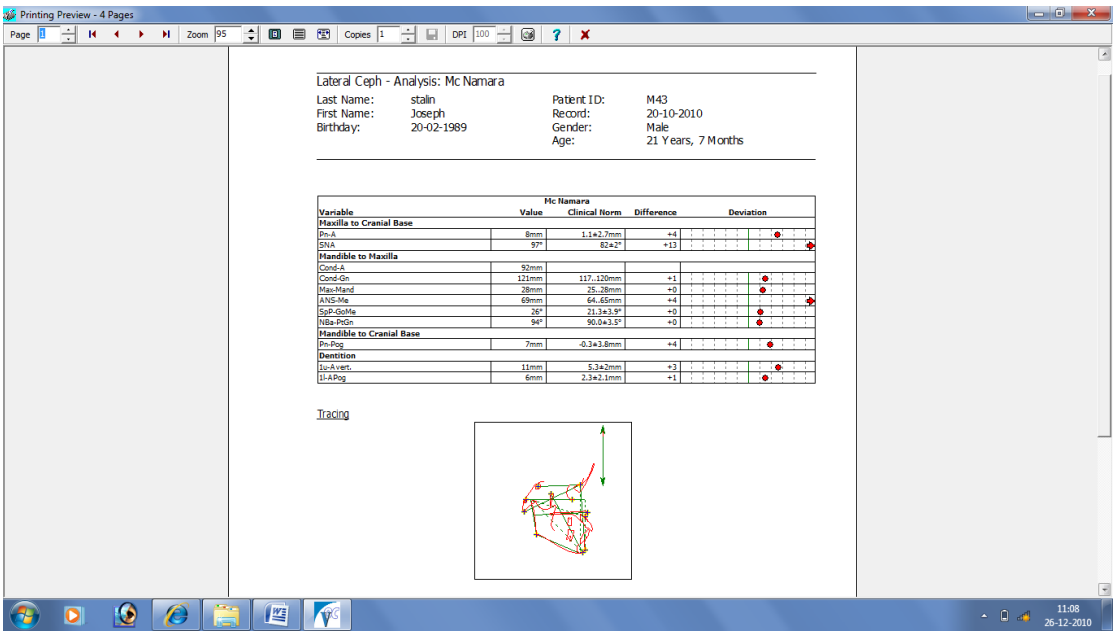



***Fig 11 Print out***

# STATISTICAL ANALYSIS

1. T-test was done to calculate the p-value for the males and females. If the p value calculated is < .05 it was considered statistically significant.
2. Pearson 2-tailed test was done to correlate the males and females with McNamara's norms. The significance was at the level 0.01
3. NPar test –Mann Whitney test for the negative values
4. Chi square test was done to compare the range values of co-gn and Ans-me
5. Reliability test was done to rule out intra examiner error.It was done by Cronbach's Alpha method.

# RESULTS

Cephalometric values were analysed of which the mean & standard deviation were compared between the males and females (Tamilnadu) and with the McNamara's norms which represent the norms established in the present study.

## Table 2

## Comparison of the midfacial length of males and females (Tamilnadu) : Co-A

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| co-a | Male | 50 | 92.22 | 2.690 | .380 |
| | Female | 50 | 90.18 | 2.833 | .401 |

## Table 2a

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| co-a | Equal variances assumed | 2.245 | .137 | 3.692 | 98 | .000 | 2.040 | .553 | .944 | 3.136 |
| | Equal variances not assumed | | | 3.692 | 97.737 | .000 | 2.040 | .553 | .943 | 3.137 |

Table 2 &2a shows the comparison of mean values of cephalometric measurements between Tamilnadu males and females. Males were found to have significantly more midfacial length than females (P<0.001).

**Table 2b**

**Comparison of midfacial length of Tamilnadu males with McNamara's norms: Male correlations**

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| CoA | 92.16 | 2.675 | 50 |
| normal | 94.20 | 1.841 | 50 |

**Correlations**

| | | CoA | normal |
|---|---|---|---|
| CoA | Pearson Correlation | 1 | .366** |
| | Sig. (2-tailed) | | .009 |
| | N | 50 | 50 |
| normal | Pearson Correlation | .366** | 1 |
| | Sig. (2-tailed) | .009 | |
| | N | 50 | 50 |

**. Correlation is significant at the 0.01 level

When compared with McNamara's norms, the midfacial length of males was found to be decreased which is statistically significant (0.01) by pearson correlation test.

**Table 2c**

**Comparison of midfacial length of Tamilnadu females with McNamara's norms: Female correlations**

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| CoA | 90.18 | 2.833 | 50 |
| normal | 92.14 | 1.841 | 50 |

**Correlations**

| | | CoA | normal |
|---|---|---|---|
| CoA | Pearson Correlation | 1 | .688** |
| | Sig. (2-tailed) | | .000 |
| | N | 50 | 50 |
| normal | Pearson Correlation | .688** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 50 | 50 |

**. Correlation is significant at the 0.01 level

When compared with McNamara's norms, the midfacial length of females were found to be decreased which is statistically significant by Pearson correlation test ($P<0.01$)

## Table 2d

**Comparison of effective mandibular length of males and females (Tamilnadu): Co-Gn**

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| c0-gn | Male | 50 | 121.06 | 2.931 | .414 |
| | Female | 50 | 117.70 | 3.157 | .447 |

The t-test revealed that males have significantly more effective mandibular length compared to females (P<0.001).

## Table 3

**Comparison of lower anterior facial height of males and females : Ans-Me**

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| ans-me | Male | 50 | 67.62 | 3.057 | .432 |
| | Female | 50 | 67.18 | .774 | .110 |

## Table 3a

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| ans-me | Equal variances assumed | 32.406 | .000 | .987 | 98 | .326 | .440 | .446 | -.445 | 1.325 |
| | Equal variances not assumed | | | .987 | 55.264 | .328 | .440 | .446 | -.454 | 1.334 |

The lower anterior facial height was found to be insignificant (P>0.05) using independent t-test.

## Table 4

## Comparison of facial axis of males and females

## (Na –Ba-Ptm-gn):

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| naba-plane | Male | 50 | 85.94 | 1.889 | .267 |
| | Female | 50 | 87.92 | 1.243 | .176 |

## Table 4a

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| naba-plane | Equal variances assumed | .597 | .441 | -6.192 | 98 | .000 | -1.980 | .320 | -2.615 | -1.345 |
| | Equal variances not assumed | | | -6.192 | 84.729 | .000 | -1.980 | .320 | -2.616 | -1.344 |

The t-test revealed that chin prominence in females is more when compared to males which is significant at $p<0.01$

## Table 5

## Comparison of pog –nperpendicular of males and females: Pog-nper

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| pog nper | Male | 50 | -2.34 | 1.364 | .193 |
| | Female | 50 | -3.98 | 2.299 | .325 |

## Table 5a

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| pog nper | Equal variances assumed | 23.553 | .000 | 4.338 | 98 | .000 | 1.640 | .378 | .890 | 2.390 |
| | Equal variances not assumed | | | 4.338 | 79.709 | .000 | 1.640 | .378 | .888 | 2.392 |

The Mann- Whitney test revealed that there is statistically significant increase in the mandibular length in males compared to females.This is a non parametric method where the Mann-Whitney test is used due to negative values and the mean is greater than two times the standard deviation ( mean>2 times the S.D).

## Table 6

## Comparison of upper incisor and lower incisor position of males and females.

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| upper incisor to aver | Male | 50 | 6.62 | 1.292 | .183 |
| | Female | 49 | 4.92 | .954 | .136 |

## Table 6a

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| upper incisor to aver | Equal variances assumed | 1.189 | .278 | 7.443 | 97 | .000 | 1.702 | .229 | 1.248 | 2.155 |
| | Equal variances not assumed | | | 7.466 | 90.189 | .000 | 1.702 | .228 | 1.249 | 2.154 |

## Table 7

**Group Statistics**

| | Sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| lower incisor to apog | Male | 50 | 4.16 | 1.017 | .144 |
| | Female | 50 | 3.40 | .857 | .121 |

## Table 7a

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| lower incisor to apog | Equal variances assumed | .277 | .600 | 4.040 | 98 | .000 | .760 | .188 | .387 | 1.133 |
| | Equal variances not assumed | | | 4.040 | 95.255 | .000 | .760 | .188 | .387 | 1.133 |

There is statistically significant increase in the upper and lower incisors position.Males have protruded upper and lower incisors compared to females. (P<0.001).

## Co-Gn range values: Table 8

Chi square test was done to compare the range values like co-gn and Ans-Me.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 38.481[a] | 12 | .000 |
| Likelihood Ratio | 47.238 | 12 | .000 |
| N of Valid Cases | 100 | | |

a. 16 cells (61.5%) have expected count less than 5. The minimum expected count is .50.

## Ans-Me range values: Table 8a

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 37.196[a] | 9 | .000 |
| Likelihood Ratio | 46.205 | 9 | .000 |
| N of Valid Cases | 100 | | |

a. 10 cells (50.0%) have expected count less than 5. The minimum expected count is .50.

**Chart 1: Comparison of midfacial length of males and females (Tamilnadu)**

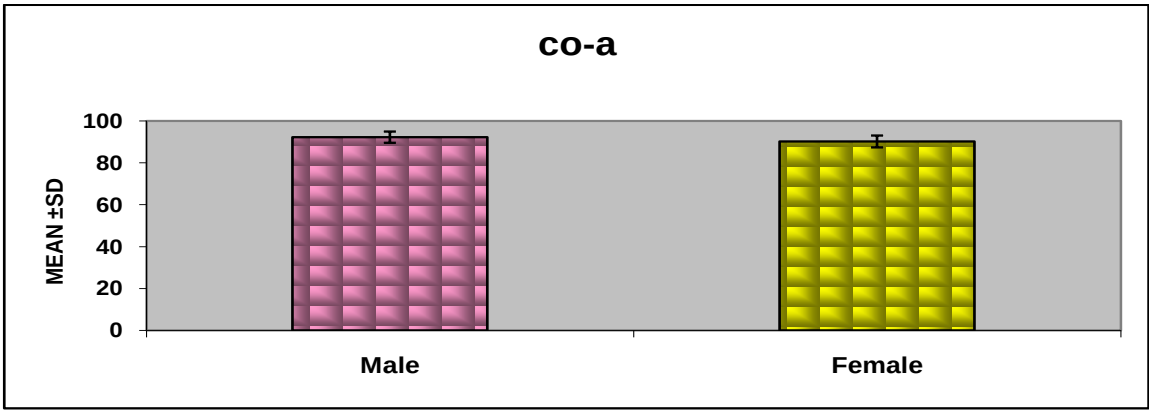



**Chart 2: Comparison of effective mandibular length of males and females (Tamilnadu)**

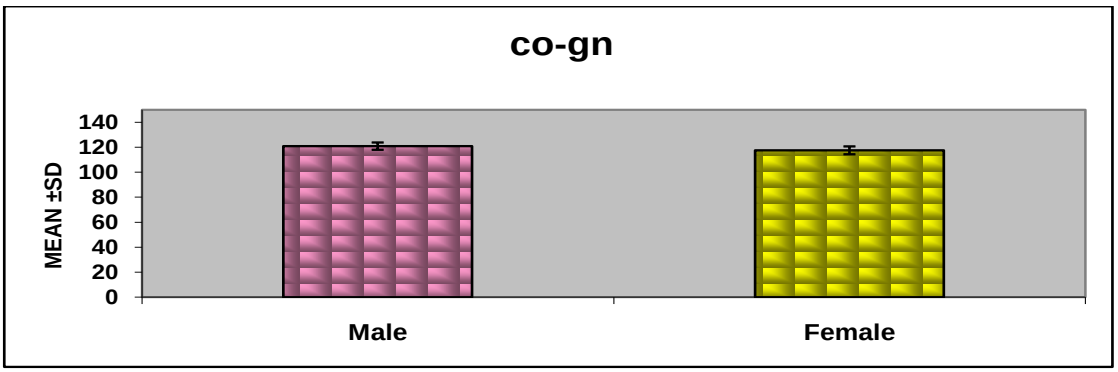



**Chart 3: Comparison of maxillomandibular differential between males and females**

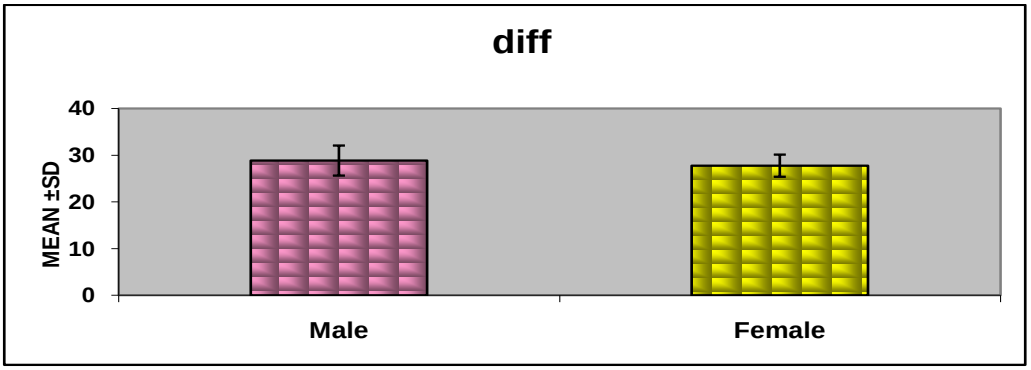


**Chart 4: comparison of lower anterior facial height of males and females (Tamilnadu)**

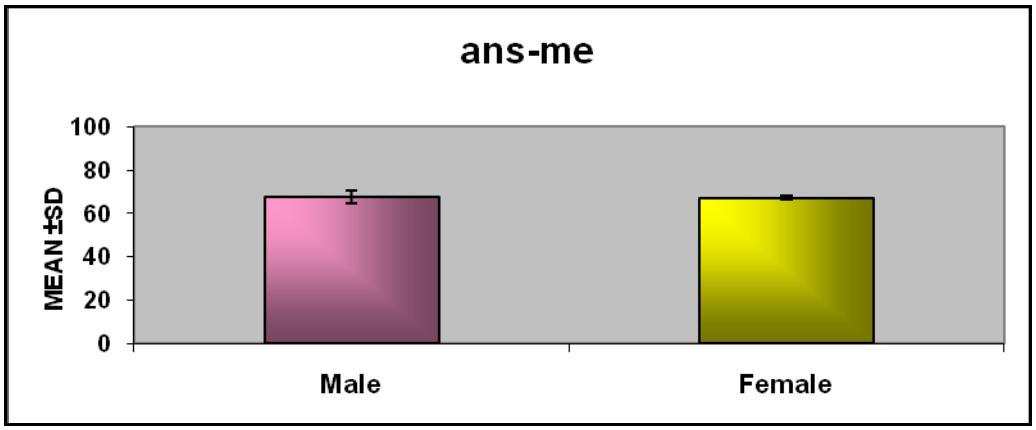



**Chart 5: comparison of facial axis of males and females (Tamilnadu)**

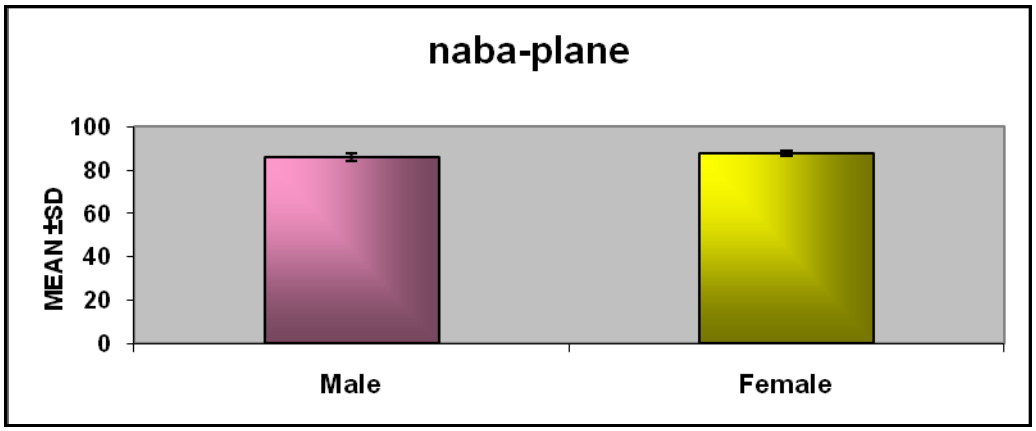



**Chart 6: comparison of nasion perpendicular to point A of males and females (Tamilnadu)**

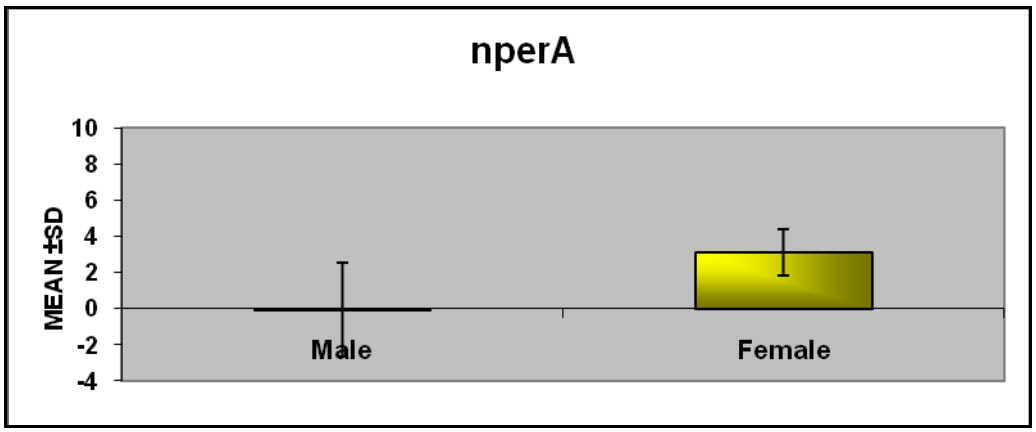


**Chart 7: comparison of pog N perpendicular of males and females (Taminadu)**

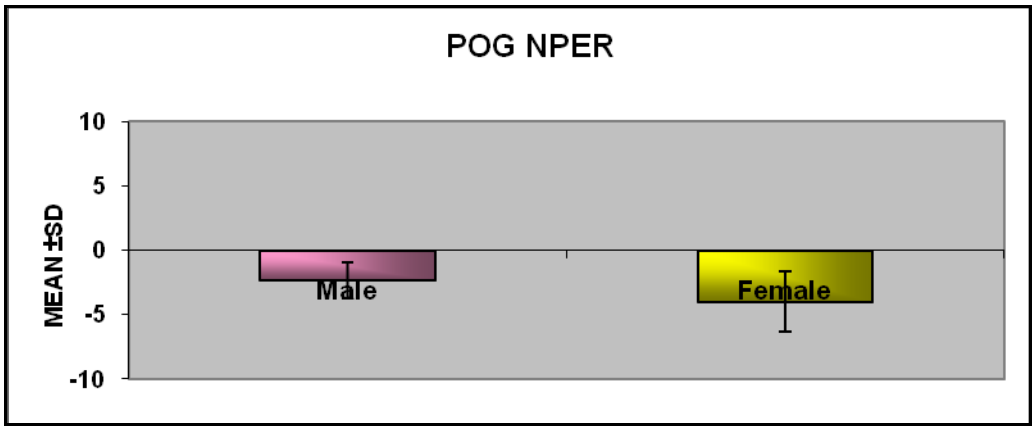



**Chart 8: comparison of upper incisor to A vertical of males and females (Tamilnadu)**

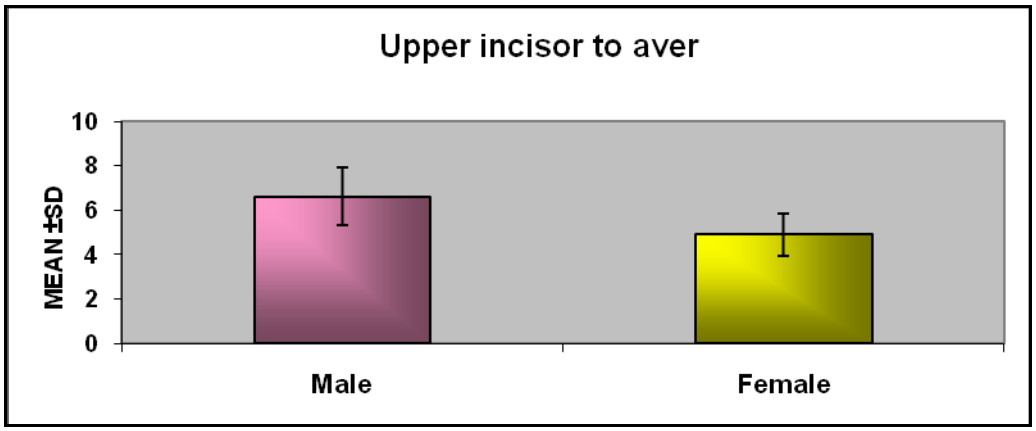



**Chart 9: comparison of lower incisor to A Pog of males and females (Tamilnadu)**

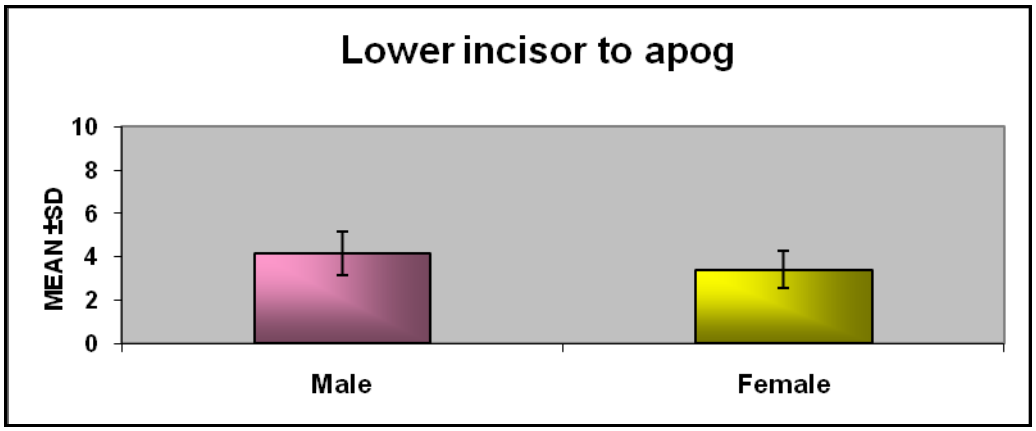
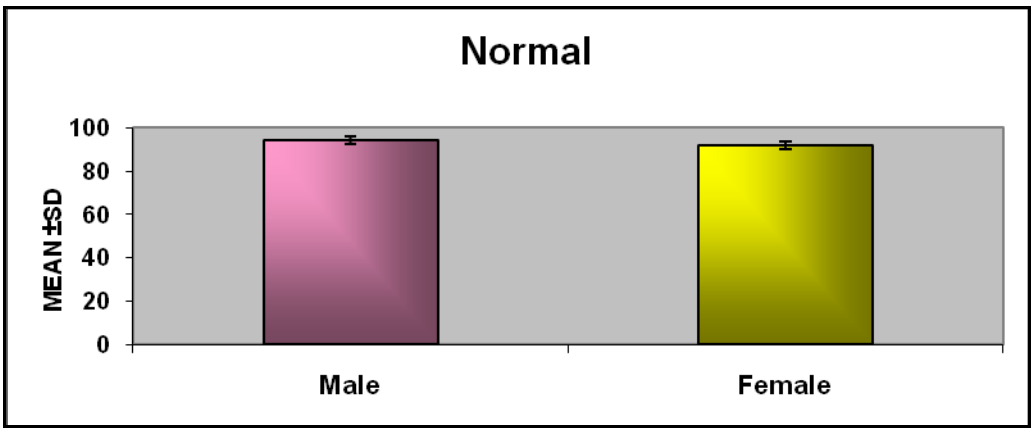


**Chart 10: normal values**



# DISCUSSION

The introduction of Cephalometric radiography by **B. Holly Broadbent in 1931**[31] , was a scientific breakthrough in the practice of orthodontics. Cephalometrics has defined as a technique for abstracting the complexities of the live human head into a geometric scheme or as a standardized technique used for the scientific measurement dimensions of the head.(Rakosi 1982). The original purpose of cephalometrics was to study the growth sequence of the craniofacial complex.they are also used for many purposes like assessing facial and dentoskeletal relationship, as an aid in treatment planning and the changes brought about by the orthodontic treatment, predicting the changes that might occur in future .(Proffitt&Fields 1993).

After **Broadbent**, the cephalometric analysis was popularised by **William Downs** [19] in his analysis which was developed at the university of Illinios. It was based on skeletal and facial proportions where he analysed a sample of 20 untreated Caucasian individuals aged 12-17 years with clinically excellent occlusions. Later **Steiner** [63]

developed cephalometric norms which are a distillation from various sources. They were not taken from any sample, but were chosen from those available at the time that he felt useful to his clinical perceptions of therapeutic goals. Tweed selected samples which he felt pleasing and set cephalometric norms. Sassouni[61] developed his cephalometric norms in 1955, using a sample of 50 whit children ranging from 7-15 years of age with normal occlusion**. Ricketts** [56] developed the cephalometric norms using less traditional points, planes and axes.

Wits appraisal by Jacobson measures the anteroposterior disharmony where it relates the jaws on to the occlusal plane.

To establish cephalometric norms for a particular population or groups, comparisons were made only with people having excellent facial proportions and good occlusion**. Richardson** defined the term ethnic group as a nation or population with common bond such as geographical boundary, a culture or language or being racially or historically related, whereas race can be defined

as groups of persons connected by common descent or origin, a family, tribe or people. In 1984**, McNamara** [46] established cephalometric norms which was derived in part from the principles of the cephalometric analysis of Ricketts and of Harvold, although other aspects such as construction of nasion perpendicular and the point A vertical are presumed to be original. He obtained 3 sets of samples, the first was that the normative data derived from lateral cephalographs of the children comprising the Bolton methods. The second sample were retracted from group of normal children from the Burlington orthodontic research centre. The third sample was from Ann Arbor sample of 111 young adults who had excellent facial configurations. They had class I occlusion and good skeletal balance with an orthognathic facial profile. McNamara's valuesare composite normative standards which were determined by arbitrarily combining comparable average values of the Burlington, Bolton and Ann Arbor samples[46]. All cephalometric measures from all samples have an 8% enlargement factor.

McNamara analysis is sensitive not only in the position of the teeth within a given bone but also to the cranial base structures. Since growth takes place in both vertical and horizontal directions taking any angular measurements may tend to misidentify jaw discrepancies. It uses linear measurements so that the treatment planning and diagnosis can be made easier.In an effort to create a clinically useful analysis, McNamara divided the craniofacial skeletal complex into five major sections as maxilla to cranial base, maxilla to mandible, mandible to cranial base, dentition and airway.

The process of digitization came into existence when in 1960 **Ricketts R.M.**[56] introduced his cephalometric analysis that has progressed through a series of modifications and been adapted to a computer-based diagnostic and treatment forecasting service. Between 1963 and 1967 much of the pioneering development and use of the computer carried out in the Philadelphia Growth center by Dr**. Krogman** and Dr. **Walker**. They further worked upon the initial work done by the researchers in Newzealand. **Digitization** is a process by which analog

information is converted into digital form. An enormous amount of information is incorporated in the anatomic contours contained in a cephalogram. A small subset of this information is of interest -precisely that which is needed to assist in making a diagnosis and treatment plan. The task is to reduce the radiographic data to a meaningful, manageable size and is accomplished through the process of digitization.

Previous cephalometric studies revealed that measurable skeletal and dental differences exist between racial groups exist.The ethnic facial features are to be considered which play a critical role in setting objectives for successful orthodontic treatment. Therefore , each different population would be best treated according to its individual's characteristics inorder to achieve an esthetically pleasing face. **In 1959, Ravindra Nanda** [54] evaluated and established the norms for North Indian populations where 50 individuals equally divided as to sex were taken lateral cephalograph. He concluded that there was protrusive skeleto dental pattern in females and the North Indian Hindus were very similar to the American

Whites. **In 2000**, **Abraham K.K, Tandon S**[1] conducted a study in 40 South Kanara children with a mean age of 8-12 years and concluded that the children showed a tendency towards Class II skeletal relation. Females showed a protrusive maxillary and mandibular base. Length of the maxillary and mandibular bases were standardized for class I cases. They also introduced new parameters on molar appraisal. **In 2001, Bhat, Sudha**[7] studied the cephalometric norms for the brahmins and Bunt children of Dakshina using Mcnamara analysis. They confirmed that the kanara children had advanced maxillary growth in Bunt boys and girls, longer lower anterior facial height in bunt boys than the Brahmin girls and proclination of upper incisors in bunt girls than Brahmin girls .Maxillomandibular length was also longer in males than in females. The present significant findings were in agreement with **John Wu et al in 2007** [42], reported fundamental variations of Chinese and McNamara's norms and also it is similar to the observations of Al-Jasser.

This study compared the untreated young adults of Tamilnadu with that of the McNamara's standards to

determine cephalometric norms. The sample was selected from the archives of lateral cephalometric radiograph files taken by the 4$^{th}$ year dental students as a part of their undergraduate orthodontic course requirements. The criteria of selection were normal occlusion, pleasant soft tissue profiles, no history of trauma and no previous orthodontic treatment. The lateral cephalographs are initially scanned and stored in the cephalometric folder. The lateral cephalographs are digitized using VistaDent cephalometric analysis computer software. The process of digitization, landmark identification and analysis were carried out by single investigator. The computer analysis software produced the measurements according to McNamara's analysis. The measurements were recorded for each radiograph. Descriptive data, mean and standard deviations were calculated for the males and females of TamilNadu . These were compared with that of the European-American samples reported by Mcnamara using t-test to find out whether significant difference at 5% level ($P<0.05$).

Method of error of the study in identifying and locating the anatomical landmarks during tracing and

measurements were assessed by t-test. 10 cephalometric radiographs were randomly selected and digitized again after 3 weeks interval by the same investigator to determine the intra-examiner error. The reliability test was done using Cronbach's alpha method where it revealed that there was no significant difference between two occasions of measurements at more than 0.6

The results were compared with males and females and these norms with that of the McNamara's standards. The study revealed that males were found to have significantly more midfacial length than females ($P<0.001$). Though the males had protruded maxilla but when compared with McNamara's norms , the midfacial length of males was found to be decreased suggestive of retruded maxilla which coincides with the study done by Al-Barakati [59]. This was statistically significant (0.01) by pearson correlation test . When compared with McNamara's norms , the midfacial length of females was found to be decreased which is statistically significant by Pearson correlation test ($P<0.01$).

The t-test revealed that males have significantly more effective mandibular length compared to females (P<0.001). The lower anterior facial height was found to be insignificant (P>0.05). The t-test revealed that chin prominence in females is more when compared to males which is significant at p<0.01.

The Mann- Whitney test revealed that there is statistically significant increase in the mandibular length in males compared to females.This is a non parametric method where the Mann-Whitney test is used due to negative values and the mean is greater than two times the standard deviation ( mean>2 times the S.D).

There is statistically significant increase in the upper and lower incisors position.Males have protruded upper and lower incisors compared to females. (P<0.001).

The midfacial length and effective mandibular length were significantly reduced when compared with males. They also showed that the upper and lower incisors are significantly less protruded when compared to males.The

lower anterior facial height was to be insignificant as that of males.The results of the investigation have clinical implication in order to diagnose and plan the treatment. TamilNadu males demonstrated more tendencies towards bimaxillary protrusion whereas females demonstrated less protrusion of upper and lower incisors when compared to males.

# SUMMARY AND CONCLUSION

1. Cephalometrics is considered an essential tool in orthodontics to assist research workers and orthodontic clinicians in diagnosis and treatment planning. With the advent of cephalometric radiography many studies were done in different parts of the world by many researchers and established their own cephalometric norms for their own population.
2. Digitization process is used where the analog information is converted into digital form.It reduced the radiographical data into manageable size and were found to be more accurate and less time consuming.
3. Mcnamara analysis is sensitive not only to the position of the teeth with a given bone and also to the cranial bone structures.
4. In this study cephalometric norms for Tamilnadu young adults were established using Mcnamara analysis.
5. The results showed that males were found to have significantly more mid facial length suggestive of protruded maxilla and more effective mandibular

length than females. The lower anterior facial height was found to be insignicant and chin prominence was more in females when compared to males. Males found to have more protruded upper and lower incisors compared to females.

6. When compared with Mcnamara norms, males and females were found to have decreased mid facial length and effective mandibular length.
7. This study emphasise the digitization process and conclude that there is significant difference in the cephalometric norms of Tamilnadu young adults when compared with the McNamara's norms. This information can be utilised in diagnosis and treatment planning.

# LIMITATIONS OF THE STUDY

## LIMITATIONS:

1. Further study is required to confirm this result on the TamilNadu population using a larger sample size.
2. Various other soft tissue analyses can also be included in further studies along with other three dimensional imaging techniques.

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